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# Evaluation of an Engineering Copier for Use in Army Command Posts

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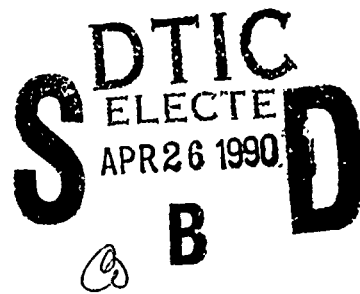
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# EVALUATION OF AN ENGINEERING COPIER FOR USE IN ARMY COMMAND POSTS

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## EVALUATION OF AN ENGINEERING COPIER FOR USE IN ARMY COMMAND POSTS

### Summary

Army command posts have a need to reproduce large items such as maps and overlays in support of combat planning and operations. Currently, the only way to reproduce large items such as overlays is by hand drawing. The evaluation documented here examines the feasibility of using an engineering copier, the Xerox 2510 Copier, to reproduce large items in garrison and field command posts. The evaluation is based on the reports of Army users and a Xerox repairman.

The Copier was trained and used in the 1st Infantry Division plans office in the garrison command post environment 10 July to 17 August 1989. The Copier was operable at the end of this period. All the surveyed garrison users recommended its use in the garrison given its current design.

The field evaluation occurred when three Xerox 2510 Copiers were taken to the Army National Training Center (NTC) 22 August-13 September 1989 and used in the Fort Riley 1st Infantry Division NTC Rotation 89-13. All three Copiers became inoperable: one broke after making 11 copies, another after 100 copies, and the third after 239 copies. The inoperability of two of the copiers was later diagnosed by a Xerox repairman as due to conditions that could have been easily fixed in the field by the users if they had been more knowledgeable about Copier operations. The third Copier had not been diagnosed at the time this report was written.

One major limitation of the field Copiers is that they must be kept level or the developer will spill or slide to the side, disabling the Copier. The weight and bulk of the Copiers and their boxes make them very hard to move and impossible to keep level while moving. Given the problems experienced with the Copiers and their current design, seven of eight of the surveyed users recommended against using them in field operations. However, if the Copiers had not become totally inoperable, six of seven surveyed users would recommend their use in the field.

All of the surveyed users said that if the Xerox 2510 were operable significant time savings in command post operations would result from its use.

The following recommendations and conclusions are based on the results of the evaluation: (1) Give users more training, especially in trouble shooting; (2) The problems of weight and developer spillage should be explored with Xerox to determine if there are easy and low cost solutions to these problems. If there are, the Copiers should be reevaluated for field use after the solutions are implemented; (3) For garrison use, the benefits of the Copier appear to outweigh its limitations.

## Description of the Xerox 2510 Copier

Figure 1 shows the Xerox 2510 Engineering Copier. The Copier makes black and white same size copies in sizes 8 1/2 x 11" up to 36" wide x any manageable length on plain paper or polyester film (mylar). The Copier is 55" wide, 20" deep, 16" high, and weighs 175 pounds. It operates on 120V AC current and draws 12 amps power. It comes with an optional stand with a paper roll holder/cutter and storage area. The cost is \$3,550 to the Army (General Services Administration price list) with additional charges for supplies and stand. A carrying box is not available from Xerox for the Copier. For the field test, a wooden carrying box was designed and constructed by Army personnel at Ft. Leavenworth.

## Evaluation Methodology

A field test of the Xerox 2510 Copier was conducted at the National Training Center (NTC), Ft. Irwin, CA. Three Xerox 2510 Copiers were used in the 22 August - 13 September Ft. Riley NTC Rotation 89-13. One Copier was used in the Brigade Operations Center (OC) and one in each of the two Battalion Task Forces Command Posts. Because power fluctuations could affect copy quality, a small dedicated generator was provided for each Copier.

A Xerox representative trained two users prior to the NTC exercise and these users trained other users. The training was completed in under one hour for all users.

Field evaluation data were collected by means of use logs and post-exercise interviews with users. A use log was attached to each Copier and users recorded number of copies made and any problems with the Copier each time the Copier was used. See Appendix A for a copy of the log form. Eight enlisted soldiers who had used the Copier at the NTC exercise were interviewed by evaluation personnel at the assembly area after returning from the field. Appendix B contains a copy of the interview form used.

One Copier was used in garrison from 10 July - 17 August 1989 in the 1st Infantry Division plans office at Ft. Riley. Two officer level Copier users were interviewed by evaluation personnel.

The evaluation results included in this report covered several topics not explicitly addressed in the use log or structured questionnaire (e.g. lack of color and adequacy of generator). Because the questionnaires were administered orally and individually, the interviewers had an opportunity to probe additional topic areas which were brought up by the interviewees. Results topics not covered on the use log or questionnaire are user initiated topics.

## Evaluation Results

### Mechanical Failures

All three Copiers became inoperable in the field. One Battalion Copier was unloaded in the assembly area at NTC, prior to going into the field. It made 11 copies and then jammed. This Copier was then left in the assembly area. The

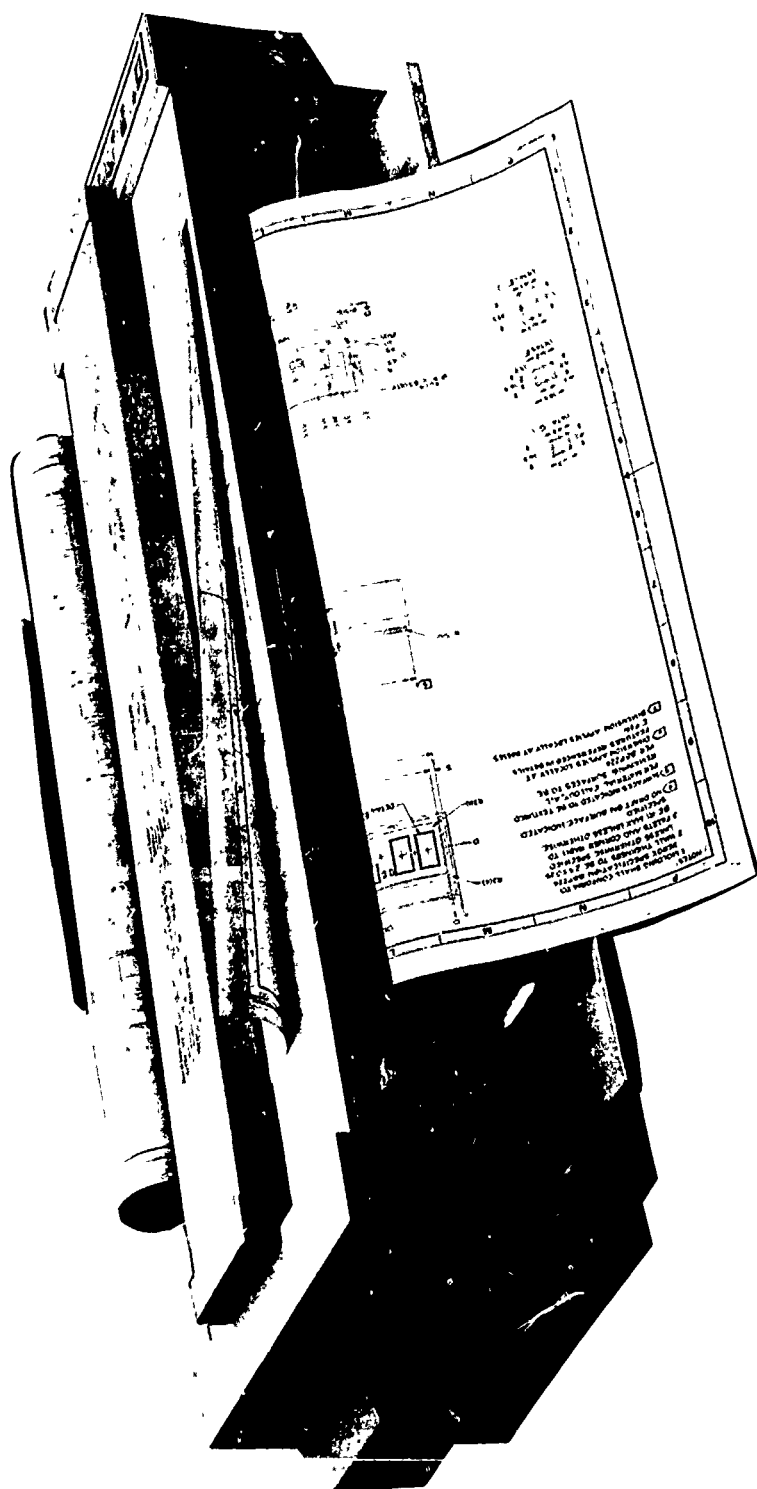


Figure 1. The Xerox 2510 Engineering Copier.



two remaining Copiers were not unloaded in the assembly area, but taken directly into the field; one was used in the Brigade OC and the other in the Battalion CP. Both experienced problems with the developer leaking, sliding to one side, and consequently printing unevenly or not at all. Repeated repairs were made by Brigade and Battalion staffs to these two Copiers to keep them functioning. Use of the Battalion Copier continued until the day before the exercise was completed. It made 249 copies. Use of the Brigade Copier was discontinued after making 100 copies because it wouldn't print.

At the conclusion of the exercise, all Copiers were transported back to Ft. Riley to be examined by a Xerox repairman. He was not able to diagnose nor repair the Copier that had made only 11 copies before becoming inoperable. The problem with the Copier that had made 239 copies was diagnosed as a paper baffle that had been inadvertently pushed down. When this Copier was returned to Ft. Riley and the paper baffle repositioned, paper would still not feed into the Copier. However, when an unopened package of paper was used to replace the old, the problem disappeared. The repairman attributed this problem to the sensitivity of the Copier to moisture in the paper. The third Copier was fixed when the Xerox repairman re-leveled the developer which had slid to one side. Both of these problems were easily fixed by the repairman and could have been fixed by any users in the field if they had been more knowledgeable about Copier functions.

The garrison Copier was used about 100 times to copy a variety of items, including overlays, maps, floor plans, and various graphics. The only repair problem occurred when a metal tab became misaligned. This was easily repaired by garrison personnel.

#### Benefits of an Engineering Copier

All users reported that a capability to mechanically copy maps and overlays in the field and garrison would be very important. It would significantly increase the time available for planning and coordinating. This savings would also mean that personnel would not have to be redirected from their regular jobs to copy overlays and orders, and that orders could be prepared in a timely manner. Users' estimates of time savings over hand copying ranged from 10-20 minutes per copy, depending on what was being copied. In a field exercise such as the one conducted at NTC, a Battalion CP making 300-600 overlays and maps would save 75-150 man hours, but would require some man hours for operational maintenance and set-ups.

A second advantage to the use of the Copier is increased accuracy of the overlays and maps, except for possible vertical stretching of long copies (see below). One user said that accuracy in hand copying may be a problem when soldiers with little sleep are tasked to copy maps. The user cited an instance where a phase line "x" looked like phase line "y" on a hand drawn copy.

The Copier could replace the Diazo, now used to reproduce orders. One user said compared to the Diazo, the Copier would be easier to use, faster, safer, there would be no chemical smell, and it would make clearer copies.

### Accuracy of copies.

All field users except two reported that the copies were accurate. One said that penciled marks did not copy. The other user said that the paper copy stretches if feeding into the Copier is not manually assisted. He said personnel at his CP experimented with the Copier "a couple of hours and figured out that you need to assist the paper or it will stretch". On the other hand, garrison users reported that for copies over five feet long, there is a significant displacement of the copy for the part of the copy reproduced last. In general, users report there is a 3% vertical deviation. For an eight foot long map, this means a three inch displacement at the part of the map copied last. One garrison user attributed this to the original and copy paper not feeding into the Copier at the same rate. The copy paper feeds slower. This can be alleviated by having a person at each side of the Copier support the copy paper and help feed it in. At corp and division level, maps eight feet long are not uncommon, and stretching of the copies may be a problem. One garrison user suggested that if the overlay were drawn directly on the map and the overlay and map reproduced together on the Copier, any stretching would not matter. Field users generally copied material less than five feet long, which may account for few of the field users reporting stretching.

### Moving the copier.

All users said one of the biggest problems was moving the Copier. In order to move the Copiers, they had to be lifted from the TRAC 577 extension tents, where they were being used, back into the TRAC 577 trucks. Because the Brigade and Battalions moved at least once a day in the field, the problems associated with moving were a significant obstacle to Copier use.

The Copier and box are estimated to weigh about 400 pounds. MIL-STD-1472D (Department of Defense, 1989) specifies a maximum design weight of 100 pounds for items requiring a lift of four feet off the ground by two men who then carry it up to 16 feet. Maximum weight for an item to be lifted by four men is listed as 200 pounds. These limits are to be decreased by one third for females. During the exercise there were often not even four men available to lift the Copier and box and the task was given to two men. The Copier and box were much too heavy for two men. In addition to the strain on the movers, using two men to move the Copier resulted in bumping, dropping and tilting the Copier. Tilting the Copier is especially problematic because this causes the toner and developer to slide to one side and spill, with the result that the Copier has to be cleaned, and the toner and developer re-leveled and perhaps replaced. If the developer cannot be re-leveled, copies will be streaked or have parts missing. The box contributes most of the weight to the Copier/box combination, and redesigning the box would alleviate some of the weight problem. However, the Copier itself weighs 175 pounds, and no box sturdy enough for field transportation could be designed to meet the mil standards of 200 pounds for a four person lift. To fully correct this problem, further consideration should be given to reducing Copier weight, configuring the Copier into smaller parcels or fixed mounting inside CP carriers or shelters.

### Copier box.

The Copier box was not supplied by Xerox. It was specially designed and constructed by the Army for transporting the Copier in the field. The following design problems emerged as a result of the field test. The box handles cut the thumb of one user; handles should be round not sharp. The box takes up too much room for convenient transportation. The handles of the box are at ground level and movers cannot position their hands under the handles in order to pick up the box. In the field, the weight of the box made it sink down into the sand, which then buried the handles in the sand where they had to be dug out. For easy carrying and balancing, the handles should be above the vertical center of gravity (Department of Defense, 1989). The top handles are useless because they are too small. Despite its weight, the Copier box was not sturdy enough. The handles and bottom edge broke on one of the two boxes that went to the field. Bolts that were designed to hold the Copier secure to the box during moving came loose.

### Dust.

Users who used the Copier in the field said dust was a continuing problem because of the need for frequent cleaning. If the Copier glass were full of dust, at best the copies would be streaked. The Copier could not be used in the blowing dust, and had to be cleaned initially before using. One user said that every time the wind blows there is dust. Dust gets all over everything when moving unless you are at the head of a column.

### Ease of use.

Users report the Copier is difficult to use in the field. The paper must be handled "delicately"; if the paper is wrinkled, the Copier will jam. If the Copier is used outside the wind blows the paper and this makes it very hard to feed into the Copier. The Copier must be level or the developer will slide to one side and print unevenly. In garrison, where wind, dust and keeping the Copier level is not a problem, users reported the Copier is easy to use.

### Temperature.

Product literature on the Xerox 2510 Copier says that the Copier should not be used in temperatures over 90 degrees. Because Army field operations are often conducted in temperatures over 90 degrees, one objective of this evaluation was to determine the effect of high temperatures on Copier performance. However, other conditions had such a great influence on Copier performance, the effects of high temperatures could not be determined. The Battalion CP Copier which was operable up to the last day of the exercise was used only at night when temperatures were below 90 degrees.

### Humidity.

The effects of humidity on Copier performance could not be tested in the NTC desert exercise. However, jamming that was attributed to the humidity was reported in garrison at Ft. Riley. User suggested solutions to this problem included keeping the paper in a plastic bag or changing to an unopened package of paper when jamming occurred.

#### Lack of color.

All users but one thought the lack of color was not a problem and that symbols could compensate for the lack of color. A Battalion user reported that without color you cannot tell the difference between roads, contour lines and intermediate streams. The lack of color is also a handicap because lines drawn on colored maps did not show up distinctively. He thought that this makes the Copier inappropriate for maps. However, all other users thought the map features could be identified by other means and lack of color was not a serious handicap.

#### Copier effect on original.

All users reported that, except for jamming, the original was not damaged in the process of copying it.

#### Developer adhesion.

All users said that the developer adhered well to the paper and mylar after printing.

#### Adequacy of facilities.

Copiers were used in the TRAC 577 extension tents. Space in the tents was reported to be adequate to house the Copiers.

#### Copier manual.

Of the users who used the manual, three said it was very adequate, and three said it didn't help when the Copier stopped working. A user devised trouble shooting instruction sheet was placed on each Copier. It is likely that this sheet facilitated routine maintenance and repairs. One user recommended that the manual should be oriented toward trouble shooting like Army equipment manuals.

#### Printing on mylar.

A clear mylar is available which substitutes for acetate when making overlays on the Copier. Seventeen copies were printed on mylar in one battalion CP. All other field and garrison copies were printed on paper. Users reported that the mylar copies came out well.

#### Generator.

All field users reported the generators performed well and did not negatively impact the Copier performance. One user commented that because of the generator's small size only the Copier can be run from it. If a larger generator were used, it could support several pieces of equipment.

## User Recommendations

### General Recommendations

On a five point scale from "strongly recommend" to strongly recommend against", seven field users strongly recommended against using the Copier in the field given its current capabilities and performance. One field user moderately recommended its use if it were fixed. Both garrison users strongly recommended its use in garrison given its current capabilities and performance.

If the Copiers had not become inoperable in the field, three field users would strongly recommend its use in the field, three would moderately recommend it, and one would recommend against using it.

### Specific Recommendations

1. Redesign the box. Add a heavy duty roller stand for paper or mylar over the top of the Copier. This would save space and make the paper more available. Position the handles higher up so they do not sink into the sand. Add more cushioning inside the box for shock absorption. Make the box lighter so that two people can carry the Copier and box. However, as discussed previously, the Copier itself weighs 175 pounds and it would be impossible to design a carrying box to meet the 100 pound MIL STD for a two man carry. Even a box for a four man carry would exceed the MIL STD.
2. Add a bubble level to the top of the Copier so users can see if the Copier is level. Add legs to the Copier in order to level it.
3. To address the problem of toner and developer spilling when the Copier is tipped, a Xerox repairman suggested that the developer housing could be easily removed before moving. It could be transported separately in a plastic bag and box. If toner and developer did spill, they could be poured back into the developer housing after moving. More study is needed to determine if this recommendation is feasible.

### Summary and Recommendations

All field and garrison users thought a copier to make oversize copies in the Brigade and Battalion command posts would make a significant improvement to command post functioning. The two garrison users surveyed recommended use of the Xerox 2510 copier for their operations, given its current capabilities and performance. Seven of eight field users recommended against the use of the Copier in the field given its present capabilities and performance. However, six of seven field users recommended field use of the Copier if it remained operable.

Major problems with the Xerox 2510 Copier include mechanical failure of all three fielded Copiers, difficulty in moving the Copier, the requirement that the Copier be kept level at all times, and displacement or distortion of the copied material, especially on long copies. With respect to the mechanical failures, it was the judgement of the Xerox repairman that at least two of the Copiers could have been repaired by users in the field. More user training

with an emphasis on trouble shooting may decrease the incidence of total mechanical failures in the field. Moving the Copier could be made easier if the size and weight of the Copier and box were decreased. The problem of tilting and subsequent developer spillage and printing problems should be examined with Xerox representatives to see if there is an easy and low cost solution to this problem. The problem of inaccurate copies could be circumvented for map overlays by drawing overlays directly on maps and copying the overlay and map together.

It should be noted that at this time the reasons for the malfunctioning of one of the field Copiers are not known. After four hours of work by a qualified Xerox repairman, the problems of the field Copier that broke after making 11 copies were not diagnosed. Any recommendations for Copier use should be contingent on the seriousness of the problems of this Copier.

In general, users perceive the benefits of an engineering copier for CP use to be very great. If the problems of mechanical failure, moving difficulty and developer spillage could be alleviated, field use of the Copier should be considered. Many of the field problems do not occur in a garrison environment, and the benefits in garrison appear to outweigh any disadvantages.

#### References

Department of Defense (14 March 1989). Military standard human engineering design criteria for military systems, equipment and facilities. MIL STD 1472D. U.S. Government Printing Office.

General Services Administration. Authorized Federal Supply Schedule Price List. Contract GS-00F-91565. Xerox Corporation, Rochester, NY.

Appendix A

# COPIER USE LOG XEROX 2510 COPIER EVALUATION Record each copier use below

Copier Serial No. 64G 002939

Check if applicable

Other  
Comments

Too Light  
or Dark

Wouldn't  
Print

Jamming

Copies  
Stretch

Damage to  
Original

No of  
Copies

What was copied?

Time

Date



Appendix B

INTERVIEW QUESTIONNAIRE

Interviewer \_\_\_\_\_

EVALUATION OF THE  
XEROX 2510 COPIER

NATIONAL TRAINING CENTER INTERVIEWS

The XEROX 2510 Copier is being considered for use by future CP staffs to reproduce overlays and prepare overlay orders. Your answer to the following questions will help evaluate the potential of the Copier for use in the CP.

(IF RESPONDENT HAS COMPLETED THE WRITTEN QUESTIONNAIRE ASK ONLY THE STARRED QUESTIONS.)

\*1. What duty position did you hold? \_\_\_\_\_ Echelon \_\_\_\_\_

\*2. How many times did you use the Copier? \_\_\_\_\_

PROBLEMS

\*3. Why did the Copier break down? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

\*4. Did anyone try to fix it?      YES      NO  
(Who? What did they do? How much time did they spend?)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

\*5. (If no), why not? \_\_\_\_\_

\*6. Were there other problems with the Copier?      YES      NO  
(What were they?)

\_\_\_\_\_  
\_\_\_\_\_

If yes, check

How was the Copier affected?

\_\_\_\_\_ Dust      \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ Moving the Copier      \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ Temperature      \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ Humidity      \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ Mechanical failure      \_\_\_\_\_

(describe) \_\_\_\_\_

\_\_\_\_\_ Accuracy of copies      \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ Adequacy of facilities      \_\_\_\_\_

(e.g. space) \_\_\_\_\_

\_\_\_\_\_ Ease of cleaning      \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ Ease of maintaining      \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ Toner came off      \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ Other      \_\_\_\_\_

\_\_\_\_\_

- \*7. What percent of the copies were made on paper? \_\_\_\_\_% on mylar \_\_\_\_\_%  
Were there any special problems with using the mylar? YES NO  
(What were they?)

---

---

- \*8. Are there any other disadvantages to using the Copier? YES NO  
(What are they?)

---

---

### ADVANTAGES

- \*9. If the Copier were working, what would be the advantages to using it?

---

---

10. How many overlays do you ordinarily draw by hand during this type of

exercise? \_\_\_\_\_ How long does each overlay take? \_\_\_\_\_

If you would use the Copier to reproduce the overlays, how much time would be saved  
by using the Copier? \_\_\_\_\_

How important would this time saving be to the effective performance of your  
operation? \_\_\_\_\_

---

11. Are errors in hand copying overlays a problem? YES NO

12. To what extent would the use of the Copier improve the performance of your

operation? \_\_\_\_\_

---

### OTHER

13. Did you use the Copier manual? YES NO  
(How adequately did it explain how to use the Copier? Maintain it? Repair it?)

---

---

\*14. Are there any Copier features that are not necessary for its use in the TOC?

(What are they?) \_\_\_\_\_

\*15. Based on your experiences with this Copier, do you recommend its use for your operation, given its current capabilities and performance?

☐ Strongly recommend    ☐ Moderately recommend    ☐ Neither recommend nor recommend against    ☐ Moderately recommend against    ☐ Strongly recommend against

If not recommended, why not? \_\_\_\_\_

\*16. If the Copier had not broken down, would you recommend its use for your operation?

☐ Strongly recommend    ☐ Moderately recommend    ☐ Neither recommend nor recommend against    ☐ Moderately recommend against    ☐ Strongly recommend against

If not recommended, why not? \_\_\_\_\_

\*17. Do you have any other comments about the Copier? \_\_\_\_\_

THANK RESPONDENT